

MATERIAL SAFETY DATA SHEET

1. SUBSTANCE AND SOURCE IDENTIFICATION

National Institute of Standards and Technology
Standard Reference Materials Program
100 Bureau Drive, Stop 2320
Gaithersburg, Maryland 20899-2320

SRM Number: 3134
MSDS Number: 3134
SRM Name: Molybdenum Standard Solution

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Description: This Standard Reference Material (SRM) is intended for use as a primary calibration standard for the quantitative determination of molybdenum. One unit of SRM 3134 consists of five 10 mL sealed borosilicate glass ampoules of an acidified aqueous solution prepared gravimetrically to contain a known mass fraction of molybdenum. The solution contains hydrochloric acid at a volume fraction of approximately 10 %.

Material Name: Molybdenum Standard Solution

Other Designations:

Molybdenum: Mo; elemental molybdenum; molybdenum metal.

Molybdenum Chloride: Molybdenum pentachloride; molybdenum(V) chloride; pentachloromolybdenum.

Hydrochloric Acid: Hydrogen chloride; hydrochloric acid, aqueous; muriatic acid.

2. COMPOSITION AND INFORMATION ON HAZARDOUS INGREDIENTS

Component	CAS Registry	EC Number (EINECS)	Concentration (%)
Hydrochloric Acid	7647-01-0	231-595-7	10
Molybdenum Chloride	10241-05-1	233-575-3	2.8
Molybdenum	7439-98-7	231-107-2	1

EC Classification, R/S Phrases: Refer to Section 15, Regulatory Information.

3. HAZARDS IDENTIFICATION

NFPA Ratings (Scale 0-4): Health = 3 Fire = 0 Reactivity = 1

Major Health Hazards: Hydrochloric acid can cause severe or fatal burns if inhaled, swallowed, or absorbed through the skin. Molybdenum chloride is also corrosive and can cause severe tissue damage. High levels of elemental molybdenum can cause respiratory tract irritation, anemia, copper deficiency, and other serious health effects.

Physical Hazards: Glass container may shatter. Protect from physical damage and heat.

Potential Health Effects

Inhalation:	Inhalation of HCl may cause death due to inflammation, spasm, and edema of the larynx and bronchi. Symptoms of exposure include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. Chemical pneumonitis, pulmonary edema, cyanosis, and rapid breathing may occur. The teeth, nasal passages, and other tissues may be damaged. Molybdenum pentachloride is also corrosive and can damage the mucous membranes and respiratory tract, causing shortness of breath and delayed pulmonary edema. Inhalation of molybdenum dust can irritate the respiratory tract; long-term exposure may be associated with anemia, gout-like symptoms, copper deficiency, and possible damage to the lungs, kidneys, and liver.
Skin Contact:	Hydrochloric acid can cause severe burns to the skin. Contact with MoCl ₅ may cause severe skin irritation and burns. Elemental molybdenum dust may also cause skin irritation.
Eye Contact:	Hydrochloric acid can cause severe burns and permanent eye damage. Contact with MoCl ₅ may cause severe eye irritation and burns. Elemental molybdenum dust may cause eye irritation.
Ingestion:	Hydrochloric acid can cause severe corrosive injury to the mucous membranes and GI tract. Internal bleeding may cause a drop in blood pressure. Other effects may include shock, metabolic acidosis, and circulatory collapse. The toxicology of molybdenum pentachloride has not been fully investigated, but target organs include the central nervous system and GI tract. Ingestion can cause headache, abdominal pain, nausea, and vomiting. Severe GI irritation and burns may occur. High intake of molybdenum may interfere with the metabolism of copper, calcium, and phosphorus.

Medical Conditions Aggravated by Exposure: Osteoporosis, anemia, lung disease, or other conditions affecting the target organs.

Listed as a Carcinogen/ Potential Carcinogen:

	Yes	No
In the National Toxicology Program (NTP) Report on Carcinogens	_____	<u> X </u>
In the International Agency for Research on Cancer (IARC) Monographs	_____	<u> X </u>
By the Occupational Safety and Health Administration (OSHA)	_____	<u> X </u>

4. FIRST AID MEASURES

Inhalation: Move the person to fresh air immediately. If not breathing, qualified personnel may start CPR or give oxygen if necessary. Get medical aid at once, and bring the container or label.

Skin Contact: Remove contaminated clothing and shoes. Flush affected skin with water for at least 15 minutes, then wash thoroughly with soap and water. If burns are severe or if skin irritation persists, get medical aid and bring the container or label. Wash contaminated clothing before reusing.

Eye Contact: Remove contact lenses (if any). Do not allow victim to rub eyes or keep eyes closed. Flush eyes with large amounts of running water for at least 30 minutes, keeping eyelids open and raising lids to remove all chemical. Get medical aid at once, and bring the container or label.

Ingestion: Contact a poison control center immediately for instructions. Wash out mouth with water, but do not induce vomiting. Get medical aid at once, and bring the container or label.

5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: Hydrochloric acid is a negligible fire hazard when exposed to heat or flames, but it reacts with many metals to produce flammable hydrogen gas. It also reacts with water to produce heat. Hydrogen chloride gas is heavier than air and may accumulate in low areas.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire: water spray, dry chemical, carbon dioxide, or foam. Use a water spray to dilute hydrochloric acid and to absorb liberated oxides of nitrogen. (These guidelines apply to the mixture; when the components are considered separately, different precautions may apply).

Fire Fighting: Avoid inhalation of material or combustion byproducts. Wear full protective clothing and NIOSH-approved self-contained breathing apparatus (SCBA).

Flash Point (°C): N/A

Autoignition (°C): N/A

Flammability Limits in Air: N/A

Lower Explosive Limit (LEL): N/A

Upper Explosive Limit (UEL): N/A

Flammability Class (OSHA): N/A

6. ACCIDENTAL RELEASE MEASURES

Occupational Release: Notify safety personnel of spills. Surfaces contaminated with this material should be covered with soda ash or sodium bicarbonate to neutralize the acid and to prevent the formation of potentially explosive hydrogen gas. Place the neutralized material into containers suitable for eventual disposal, reclamation, or destruction. Empty containers may retain hazardous product residues. Do not flush to sewer.

Disposal: Refer to Section 13, Disposal Considerations.

7. HANDLING AND STORAGE

Storage: Store unopened containers of this material in a dry place with acid-resistant flooring at room temperature. Protect from physical damage, direct sunlight, heat, and incompatible materials.

Safe Handling Precautions: Wear gloves and chemical safety goggles (Section 8). Engineering controls should maintain airborne concentrations below TLV (Section 8).

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Hydrochloric Acid:

ACGIH TLV-TWA: 5 ppm or 7 mg/m³
OSHA PEL: 5 ppm or 7 mg/m³
UK WEL-TWA: 2 mg/m³

Molybdenum Chloride:

ACGIH TLV-TWA: 5 mg/m³
OSHA PEL: 5 mg/m³
UK WEL-TWA: 10 mg/m³

Molybdenum:ACGIH TLV-TWA: 10 mg/m³OSHA PEL: 15 mg/m³UK WEL-TWA: 10 mg/m³

Ventilation: Use local or general exhaust to keep employee exposures below limits. Local exhaust ventilation is preferred because it can control contaminant emissions at the source, preventing dispersion into the general work area. Refer to the ACGIH document *Industrial Ventilation, a Manual of Recommended Practices*.

Respirator: If necessary, refer to the NIOSH document *Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR 84* for selection and use of respirators certified by NIOSH.

Eye Protection: Use chemical safety goggles where dusting or splashing of solutions may occur. See OSHA standard (29 CFR 1910.133) or European Standard EN166. The employer should provide an emergency eye wash fountain and safety shower in the immediate work area.

Personal Protection: Wear appropriate gloves and protective clothing to prevent contact with skin.

9. PHYSICAL AND CHEMICAL PROPERTIES

Hydrochloric Acid	Molybdenum Chloride	Molybdenum
Appearance and Odor: Colorless liquid; pungent, irritating odor (may be undetectable at PEL).	Appearance and Odor: Black or gray deliquescent crystals	Appearance and Odor: Gray-black powder
Relative Molecular Weight: 36.46	Relative Molecular Weight: 273.21	Relative Molecular Weight: 95.94
Molecular Formula: HCl	Molecular Formula: MoCl ₅	Molecular Formula: Mo
Specific Gravity: 1.05 (10%)	Specific Gravity: 2.928	Specific Gravity: 10.2
Solvent Solubility: Soluble in alcohol and benzene	Solvent Solubility: Soluble in dry ether, dry alcohol, concentrated mineral acids, liquid ammonia, chloroform, carbon tetrachloride, and organic solvents.	Solvent Solubility: Soluble in hot concentrated sulfuric acid, nitric acid, and aqua regia.
Water Solubility: Soluble, with slight evolution of heat	Water Solubility: Reacts with water	Water Solubility: Insoluble

NOTE: The physical and chemical data provided are for the pure components. Physical and chemical data for this solution do not exist. The actual behavior of the solution may differ from the individual components.

10. STABILITY AND REACTIVITY

Stability: X Stable Unstable

Stable at normal temperatures and pressure.

Conditions to Avoid: Incompatible materials, combustible materials, heat, and moisture.

Incompatible Materials:

Hydrochloric Acid: Incompatible with cyanides, metals, hydroxides, amines, bases, metal cyanides, oxidizing materials, acids, halocarbons, combustible materials, halogens, and metal salts. HCl reacts with many metals to produce flammable hydrogen gas.

Molybdenum Chloride: Incompatible with water (liberates toxic gas), water (reacts violently), and strong oxidizing agents.

Molybdenum: Incompatible with halogens, oxidizing materials, and bases.

Fire/Explosion Information: See Section 5.

Hazardous Decomposition: Thermal decomposition of hydrochloric acid may release acid halides. Thermal decomposition of molybdenum pentachloride may release hydrogen chloride and/or chlorine gas. Molybdenum releases irritating fumes at temperatures above 400°C.

Hazardous Polymerization: ☐ Will Occur ☒ Will Not Occur

11. TOXICOLOGICAL INFORMATION

Route of Entry: ☒ Inhalation ☒ Skin ☒ Ingestion

Hydrochloric Acid:

Human, inhalation: LC_{Lo} (30 min) = 1300 mg/kg

Human, inhalation: LC_{Lo} (5 min) = 3000 mg/kg

Rat, oral: LD₅₀ = 700 mg/kg (31.5% in water)

Molybdenum Chloride: No toxicity data found.

Molybdenum:

Rat, oral: 10 mg/kg in diet resulted in impaired reproductive performance.

Rabbit, intratracheal: 70 mg/kg (9 mo.) caused lung disease.

Target Organ(s): Respiratory tract, teeth, skin, eyes, blood, bones, kidneys, liver, central nervous system, GI tract.

Mutagen/Teratogen: The reproductive effects of this mixture and its three components have not been fully investigated.

Health Effects: See Section 3.

12. ECOLOGICAL INFORMATION

Hydrochloric Acid: When released to water, HCl is ionized. Neutralization depends on the buffer capacity of the water. The solubility of HCl indicates a high mobility in soil.

Bluegill (*Lepomis macrochirus*): LC₅₀ (96 hrs) = pH 3.5

Mosquitofish (*Gambusia affinis*): LC₅₀ (96 hrs) = 282,000 µg/L

Common Shrimp (*Crangon crangon*): LC₅₀ (48 hrs) = 260,000 µg/L

Environmental Summary: This mixture is expected to be (at most) slightly toxic to aquatic life. The environmental effects of some components have not been fully evaluated.

13. DISPOSAL CONSIDERATIONS

Waste Disposal: One or more components of this mixture is a RCRA hazardous waste. Dispose of container and unused contents in accordance with federal, state, and local requirements for acid waste, which vary according to location. Decontaminate containers before recycling. Processing, use, or contamination of this product may change the waste management options.

14. TRANSPORTATION INFORMATION

U.S. DOT and IATA:

Hydrochloric Acid Solution: Hazard Class 8, UN1789, Packing Group II

15. REGULATORY INFORMATION

U.S. REGULATIONS

CERCLA Sections 102a/103 (40 CFR 302.4):

Hydrochloric Acid: RQ = 5000 lbs.

Molybdenum Chloride: Not regulated.

Molybdenum: Not regulated.

SARA Title III Section 302: Hydrochloric acid is regulated in anhydrous or gas form only.

SARA Title III Section 304: Hydrochloric acid is regulated in anhydrous or gas form only.

SARA Title III Section 313: Hydrochloric acid is regulated in anhydrous or gas form only.

OSHA Process Safety (29 CFR 1910.119): Hydrochloric acid is regulated (TQ = 5000 lbs).

SARA Title III Sections 311/312 Hazardous Categories (40 CFR 370.21):

ACUTE: Yes

CHRONIC: No

FIRE: No

REACTIVE: Yes

SUDDEN RELEASE: No

STATE REGULATIONS

California Proposition 65: None of the components are regulated.

CANADIAN REGULATIONS

WHMIS Classification:

Hydrochloric Acid: D1A (very toxic material), E (corrosive material)

EUROPEAN REGULATIONS

EU/EC Classification:

Hydrochloric Acid: T (Toxic), C (Corrosive)

Molybdenum Chloride: Xn (Harmful); not listed in Annex I of Directive 67/548/EEC.

Molybdenum: Xn (Harmful); not listed in Annex I of Directive 67/548/EEC.

Risk Phrases (mixture):

R23 (toxic by inhalation)

R25 (toxic if swallowed)

R35 (causes severe burns)

R36/37/38 (irritating to eyes, respiratory system and skin)

Safety Phrases (mixture):

S26 (rinse and seek medical advice after contact with eyes)
S28 (wash after contact with skin)
S36/37/39 (wear suitable protective clothing)
S45 (in case of accident or illness, see doctor; show label)

NATIONAL INVENTORY STATUS

U.S. Inventory (TSCA): All components are listed.

TSCA 12(b), Export Notification: No components are listed.

16. OTHER INFORMATION

Sources:

IUCLID Chemical Data Sheet: Hydrogen Chloride. European Chemicals Bureau, 19 February 2000.

IUCLID Chemical Data Sheet: Molybdenum. European Chemicals Bureau, 19 February 2000.

PAN Pesticides Database: Hydrogen Chloride.

Spiridonova VS, Surorov SV, On the mechanism of acute toxic action of chlorides of rare metals. *Gigiena i Sanitaria* 1967;32(12):79-82.

U.S. Agency for Toxic Substances and Disease Registry (ATSDR): Medical Management Guidelines for Hydrogen Chloride (HCl).

U.S. National Institute for Occupational Safety and Health, *NIOSH Pocket Guide to Chemical Hazards*, September 2005 edition. DHHS (NIOSH) Publication No. 2005-151.

Disclaimer: Physical and chemical data contained in this MSDS are provided only for use as a guide in assessing the hazardous nature of the material. The MSDS was prepared carefully, using current references; however, NIST does not certify the data in the MSDS. The certified values for this material are given in the NIST Certificate of Analysis.